

ARE YEAST EXTRACTS JUSTIFIABLE AS SUBSTITUTES FOR EXTRACT OF MEAT?

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THERE are few features of everyday English life which impress one who has for some years not resided in England more forcibly than the mad rush after cheap goods, almost irrespective of their actual worth. A necessary stimulus to this unreasonable striving to obtain that which is cheap without any conscientious attempt to consider whether that which is bought possesses any, or what, value, is the unscrupulous manner in which some articles are advertised. Whilst legitimate advertisement is of the utmost advantage to the public in bringing to their knowledge useful and valuable products which otherwise would escape their attention, the harm done by exaggerated and fictitious advertisements can scarcely be over-estimated. The public, with very few exceptions, absolutely destitute of the scientific knowledge which would enable it to arrive at a correct judgement, appears to accept all which is written as valuable truth and falls easily a prey to statements which are absolutely fallacious and are only advanced in the interests of those actuated by the "*argenti sitis importuna famesque*," which leads it to consider no assertion, however erroneous and misleading, unworthy of being foisted upon it, providing it brings grist to the mill of the vendor.

The above remarks find a startling illustration in the manner in which during the last few years a series of preparations, disguised with an ingenuity worthy of a better cause and which really commands a peculiar kind of admiration, have been recommended far and wide, as equivalent to absolutely different preparations of which the value as aids to nutrition admits of no doubt whatever. I refer to the system by which yeast extracts, pure or mixed with enough of extracts of beef to give them some of the odour and the taste which are characteristic of such extracts, have been advertised and sold as the equivalents of the necessarily more costly, more valuable, and innocuous extracts of beef.

I have only to refer to the preparations sold in Germany (the country which usually protects its citizens from the wiles of the dangerous drug-seller or dangerous food-empiric), under the names of "Ovos," "Wuk," and "Siris," to the many similar preparations sold in this country, the most widely advertised of which are the so-called "Ox-cup," "Juvis Tablets," and to "Fluid Juvis," in illustration of my statements.

Referring to "Ju-Vis," it is alleged in one of the many circulars which accompany the tablets and juice as follows:

Fluid Ju-Vis is made *solely* from Beef Extract with valuable Vegetable properties added, which accounts for its far superior flavour.

Fluid Ju-Vis contains *all the nourishment* of Fluid Extract prepared solely from Beef. A guarantee of its absolute purity is affixed to each Bottle.

As science progresses new sources of food products are discovered—qualities are improved and prices cheapened, to the great benefit of mankind. For years people have been content with Beef Extracts and Fluid Beef for making Beef Tea.

To correct the crudeness of Meat Extracts, celery and other vegetable flavourings, of little food value, have hitherto been used.

The new Beef Tea (Fluid Ju-Vis) inaugurates a new era. Recently a new Vegetable Extract has been produced, of the same nutrient value as the best Extract of Beef. When this is added to Extract of Beef, as it is in Fluid Ju-Vis, it greatly improves the flavour, without any loss of nourishing properties.

In the old way you get the flavouring with little strength—in the new way you get flavouring and strength at the same time.

To sum up, Fluid Ju-Vis contains all the nourishment of Fluid Extract prepared solely from Beef, but in buying Fluid Ju-Vis you get about double the value for money as compared with the usual Fluid Beef Extracts.

The value of the statements which I have thought it right to quote is appreciated to the full when we read the statement of counsel for the defendant in the case tried last year. In this the defendant appeared

to answer summonses taken out under the Merchandise Marks Act in reference to the sale of "Ox-Cup" and "Ju-Vis," to which it was alleged a false trade description was applied. The counsel referred to admitted that Ju-Vis was a combination of meat extract (the value of any sample of which is an indefinite or unknown quantity, *x*), of gelatin, and vegetable extract. "The composition was 18 per cent. of meat extract, 21 per cent. of yeast extract, and the rest was made up of gelatin, flavouring and water." It was asserted by Mr. Otto Hehner, the eminent consulting chemist, who gave evidence for the prosecution, that the amount of meat extract in "Ju-Vis" only amounted to 8 per cent., a statement based on his estimation of the amount of creatin *plus* creatinin present in the extract. On the other hand, the consulting chemists who gave evidence for the defendant asserted that their analyses bore out the statements of the manufacturer that "Ju-Vis" actually contained 18 per cent. of meat extract. The researches of Mr. Hehner, subsequently published and to which I shall refer again in this paper, leave, however, no shadow of doubt that assuming that meat extract was present in "Ju-Vis" in the proportions stated, this meat extract must have been of extraordinarily low quality, the amount of creatin *plus* creatinin in extracts of meat being remarkably constant.

After stating the composition of "Ju-Vis," according to the declaration of the manufacturer, counsel added "that it was admitted that yeast extract was a wholesome article and had great nutritive properties." (See under the heading "The Merchandise Marks Act," in the *Times* for April 23rd, 1907.) We shall presently see what value attaches to this statement of counsel on behalf of the defendant.

If we refer to a circular marked "Important," and bearing the address "Mincing Lane House, 59, Eastcheap, E.C.," which is forwarded "With the compliments of the Marmite Food Extract Company, Ltd.," we find analyses of two preparations, the first of which leads the analyst to conclude from his analyses that "*this entirely vegetable extract possesses, according to these results, the same nutrient value as a well-prepared meat extract.*"

The second analysis is supplemented by the remark: "*The preparation serves the purpose of a stimulant in much the same way as does meat extract, while it also contains a definite proportion of real nutritives.*"

On the back of this "Important" analytical and critical statement, rendered prominent by an eye-catching and ornate border, appears the following:

STATEMENT

by

An Eminent Scientific Authority on the Manufacture and
Composition of
MARMITE.

Marmite is a scientifically manufactured food product, into the composition of which the modified protoplasm of yeast enters. The fact that yeast is used in its manufacture has resulted in its being described as "extract of yeast," an expression which might lead one to suppose (and indeed is often used with the intention of creating that impression) that Marmite is merely a product resulting from the extraction of yeast. This, however, is not the case, for the yeast during the process of manufacture undergoes a remarkable series of changes, as a result of which a product is obtained having all the stimulating and nutritive properties of extract of meat. Marmite is, it is true, prepared from yeast, but in the same way that brandy is prepared from grapes, or rum from sugar, and it is no more correct to say that Marmite is extract of yeast than it would be to describe brandy as extract of grapes, or Jamaica rum as extract of sugar.

Quousque tandem?

(It is only fair to state in defence of this preparation that it is not alleged that it contains any extract of meat; the fact remains, however, that in the passage quoted above it is stated that the product has "all the stimulating and nutritive properties of extract of meat.")

It appears to me desirable from the point of view of clearness, in attempting to elucidate the subject of this paper, to discuss the questions which suggest themselves under a series of separate heads, keeping the discussion of the one, as far as possible, separate from the other, though it will be impossible to avoid some degree of repetition or some overlapping (*sit venia verbo*) of the facts and arguments.

I.

*What is Extract of Beef, looked upon from (as nearly as possible) a chemical point of view?**

It appears that already at the beginning of the nineteenth century, Proust and Parmentier by concentrating an infusion of meat, obtained a preparation which they recommended as a strengthening agent for sick people. It was only, however, in 1857 that Justus von Liebig pointed out the economical advantages which would result to the inhabitants of Europe were the teeming herds of America employed on a large scale, and under rationally directed supervision, for the preparation of extract of meat.

It was many years later that the process of preparation of meat extracts was worked out by the great and lamented Max von Pettenkofer, and only from 1887 that the actual process was carried out on a large scale in Fray Bentos (Uruguay) by Gilbert.

Seeing that the Liebig's Extract of Beef was the first of all the genuine meat extracts, and that it may be taken as a type of all which are honestly prepared, it may be well to state briefly how it is prepared.

The flesh of recently slaughtered animals is carefully freed from bones and fat, finely subdivided by the action of mincing machines and mixed with an equal quantity of water. The pans into which the mixture of minced meat and water is placed are gradually heated by steam to the temperature of 70°C. (158° Fah.), and maintained for some hours at this temperature, after which the mixture is filtered, the solid residue again treated with water and subjected to a repetition of the original process. The liquid extracts thus obtained are next placed in narrow-necked vessels and allowed to cool, with the object of separating the last traces of fats. Then commences the process of evaporation and concentration, which is carried out at first in steel pans, but subsequently in glazed pans, until the extract has been reduced by evaporation to the consistence of a syrup. During the process of cooling, the extract separates into two layers, of which the lower consists of extractive matters and salts and the upper of the easily soluble proteids. In order to prevent the separation of these two layers, the mass is continually stirred during the process of cooling. Neither common salt nor any other salt whatever is added. In the preparation of 1 kilogram (2.2 English lb.) of meat extract, 34 kilos of boneless fat-free meat are required.¹

What is the mean composition of Ox-Beef?

In the mean it contains 74.5 per cent. of water and 25.5 per cent. of solid matters, of which 23.5 are organic and approximately 1.0 per cent. mineral. Of albuminous matters, the muscle contains 21 per cent., of which about 6 per cent. are soluble and 15 per cent. insoluble in water. The difference between the albuminous matters and the total organic matters (namely, 2.5 per cent.) is made up of glycogen (.07 per cent.), lactic acid (1.0 per cent.), inositol (.03 per cent.), and approximately 0.8 per cent. of so-called nitrogenous bases to be more particularly examined in the sequel. Of all the constituents of muscle, the greater part of the salts, the nitrogenous bases, the glycogen, the inositol, and the lactic acid, doubtless, pass into the water of infusion, which is subjected to concentration.

Turning our attention now to the nitrogenous bases, we find that these consist chiefly of:

Creatin and Creatinin—characteristic of meat extracts, but completely absent in yeast extracts. Bases formerly called "Xanthin Bases," now denominated "Purin Bases."

Of the Purin Bases the following are present in meat extract, the individual bases being placed in the order of their respective amounts:

1. Hypoxanthin (Mono-oxypurin), $C_5H_4N_2O$.
2. Xanthin (Dioxypurin), $C_5H_4N_2O_2$.
3. Adenin (Aminopurin), $C_5H_5N_4ONH_2$.

The first body, hypoxanthin, far exceeds in amount, in meat, the other two purin bases: the last-named, adenin (the predominant purin base in yeast extracts), is present in meat extracts in infinitely smaller proportions, and can only be obtained from these by repeated extractions. (See reference to Karl Micko's work to be subsequently quoted.)

Guanin (amino-oxypurin), $C_5H_5N_4O.NH_2$, which is the purin base which is closest to the purin body which we know as uric acid (trioxypurin), $C_5H_4N_4O_2$, is not present

in meat extract, but in yeast extracts is next in quantity to adenin (Karl Micko).

I shall refer to the purin bases again in connexion with yeast extracts, and again when speaking of their relation to uric acid when discussing our present knowledge of the facts connected with the pathology of gout.

Before leaving the consideration of the principal constituents of meat, there are, however, several points which had better be discussed in this place.

1. Creatin and its anhydride creatinin, though, so far as we at present know, valueless as foodstuffs, that is, in the sense of not contributing either to the matter or the energy of the body, may and probably do play a part in conditions of inanition which has not yet been considered. Certainly, according to the statements of that great and accurate authority on nutrition, C. Voit,² they are entirely excreted unchanged in the urine in the course of twenty-four hours. These observations of C. Voit's, made on animals in a state of more or less perfect nutritive equilibrium, do not appear to me, however, as proving the inutility of these two bodies in the metabolism of muscle. Their constant presence in the muscular juice of all animals very probably indicates a part played in the processes which have their seat in muscle which may be of real importance. The patient who has for days and sometimes for weeks been in a state of greater or less fever, who has *pari passu* with the wasting of the muscular system, lost and continues to lose the creatin and creatinin of

he muscular juice, may derive a part of the benefit which accrues from the ingestion of meat and meat extracts from these two bodies, though they are neither permanently stored in the body, nor burned in it. I consider it beyond the province of this paper to discuss the synthesis and constitution of creatin or the hypotheses which have been advanced for and against the view that it is a precursor of urea. It might be worth mentioning, however, that whilst the excretion of creatin and creatinin is about 0.5 gram (7.5 grains) per diem, it is calculated that the muscular tissue of the average man contains, at any one time, as much as 100 grams of these bodies (mainly creatin).

Whatever truth there may be in the hypotheses which I have advanced, it has been proved (O. Hehner) that creatin *plus* creatinin offers a most valuable and reliable test for ascertaining whether an extract of yeast contains any, and how much, meat extract, seeing that the former contains no trace of either creatin or creatinin.

In meat juice creatin exceeds in quantity its anhydride creatinin, into which it is readily converted, so that in extract of meat, the conversion having occurred, it is creatinin which preponderates. Jaffé pointed out that when creatinin is treated with a saturated solution of picric acid, and a certain, not too large, volume of a 10 per cent. solution of sodium hydroxide, there is formed a creatinin picrate, $C_4H_7N_3O.C_6H_3N_3O_7$, which dissolves in the sodium hydroxide solution with the formation of a blood-red colour. The quantitative estimation of creatin and creatinin (first worked out by Baur and Barschall, and afterwards by Grindley and Woods), the creatin being first entirely converted into creatinin, has been subjected to a critical investigation by Mr. Otto Hehner, who has pointed out the fallacies attaching to Baur and Barschall's and Grindley and Wood's method when applied to a product containing so large a proportion of creatin and creatinin as genuine extract of meat. Employing his perfected method in the analysis of various meat extracts Mr. Hehner has found the amount of creatin and creatinin present in unquestionably genuine meat extracts to be as follows:—10.4, 10.7, 10.4, 11.1, 10.6, 11.4, 10.2, 10.8, 12.2, 11.3, and 10.6 per cent. respectively.

This method allows an exceedingly close approximation to be made to the amount of meat extract added to a sophisticated yeast extract, in order to impart to it some of the odour and some of the flavour of genuine meat extract. The estimate of the amount of meat extract added will, naturally, only hold good in the case of the latter possessing—as all genuine meat extracts ought to do—a normal creatin-creatinin value.

In addition to "purin bases" present in much smaller quantity than in extract of yeast, extracts of meat possess the peculiar aroma which everyone knows, and presumably contain other hitherto unseparated proximate principles which, in all probability, account in great measure, if not entirely, for its stimulating properties. It may be that

*In the preparation of the first part of this section, I have to acknowledge my indebtedness to the monograph by Professor Wilhelm G. Ruppel, entitled *Die Proteine*, which appeared in the *Beiträge zur experimentelle Therapie*, herausgegeben von Geh. Med. Präp. Prof. Dr. E. Behring, Heft 4, Marburg 1900.

traces of adrenalin, of the numerous enzymes, etc., which will be afterwards referred to, play a part in its beneficent action.

II.

What is Extract of Yeast, looked upon from (as nearly as possible) a chemical point of view?

From the admirable paper published by Professor Heinrich Zellner in the year 1903,³ as well as from a number of patents, foreign and English, we are in a position to understand what is meant by an extract of yeast. According to Zellner, it was the late Professor Buchner of Munich who was amongst the first to obtain a patent for making a yeast extract, his patent establishing a claim to a method "of obtaining yeast albumen for use as nourishment." Buchner had lost sight of the fine and *path-breaking* researches of Kossel, who had shown that the protoplasmic matter of such animal cells as those of liver, spleen, thyroid, thymus, etc. (which are carefully excluded from extract of meat), and also very particularly the protoplasm of yeast, abounds in nucleo-proteids, those phosphorus-containing proteids which readily break up, liberating nucleic acids, which in their turn set free large quantities of "purin bases." A yeast albumen, such as was contemplated in Buchner's patent, could not fail to be very rich in this class of bodies, which it was recognized, even at that time, should, so far as possible, be only most sparingly introduced into the economy.

In his paper Zellner, discussing "Ovos," "Wuk," and "Siris," besides describing their general process of manufacture and furnishing certain analytical details, in part derived from the researches of Micko which have been already referred to by me, and to which I shall return in the sequel, poses the following questions:—

In estimating the value of yeast extracts, three questions first press for an answer:

1. Can they serve merely externally as substitutes for meat extracts?
2. Do they really contain valuable extractives and stimulants, the meat bases and meat salts identical with those of true meat extracts?
3. Do they not generally, perhaps, exercise an unfavourable influence on the system, on account of the large amount of nuclein which they contain?

To these three questions Zellner briefly and, so far as he goes, with absolute correctness, replies as follows:

According to our present knowledge of them and according to our observations, the first question may be answered in the affirmative, the second may be denied (that is, that they contain valuable extractives and stimulants, etc.), while a practical decision as to the third can only be arrived at when the physiological results of experiments are made known.

As a matter of fact, had Zellner written his paper to-day, he would have been able to answer this third question more definitely and to have said that the administration of yeast extracts leads to an enormous increase in the purin bases which are excreted.

Yeast cells, in addition to their cellulose envelope, contain a protoplasm which, besides containing doubtless normal albuminous matters, is peculiarly rich in nucleo-proteids, bodies which readily split up into proteids and nucleic acids, of which several are known; all the nucleic acids are rich in phosphorus and on decomposition yield phosphoric acid, "purin bases," and so-called "pyrimidine bases," of which thymine may be taken as a type, besides carbohydrates of the pentose or xylose type. It results from the researches of Walter Jones and myself⁴ that the nucleo-proteids are, so far as they have been examined, all dextrogyrous bodies, all other albuminous bodies and albuminous derivatives being laevogyrous, with the exception of haemoglobin.⁵

The maker of yeast extracts, by the action of water (usually heated), or by the action of water and ether, or water and ether vapour, succeeds in bursting the cellulose envelope of the yeast cells and setting free the protoplasm contents and juices. The filtered liquid is then concentrated *in vacuo* or in the air and furnishes the extract, which is used either alone or with the addition of a certain proportion of meat extract in order to confer upon it such an odour and flavour as will lead the unwary to fancy that they are really partaking of meat extract or of a beef tea made from it.

In one well-known preparation, gelatin is added to the mixed yeast and meat extracts, so that tablets are obtained which are soluble in hot water and which confer upon the solutions the property of forming a strong jelly on cooling.

The value of gelatin (in days gone by the supposed strengthener of poor fevered and emaciated invalids, who were plied with jellies and gelatinous soups, under the impression that they possessed a real and important nutritive value) is one which can only be maintained on the slenderest ground. We know that gelatin differs in important particulars from the normal proteid bodies, and it is, doubtless, for this reason that it can only partially take their place in a normal diet. It contains much glyocol and very little leucin and aromatic amino acids. Given to starving animals, gelatin administered in large quantities may diminish the proteid decomposition by 20 or 30 per cent., but by giving quantities three or four times as large, the proteid economy may, at the most, be increased to 40 per cent. instead of being tripled or quadrupled. However large the amount of non-nitrogenous food added to a diet containing the largest possible gelatin amount, it is absolutely impossible to prevent the loss of the proteids of the body. From these considerations it follows that *however useful in impressing the public* with the idea of fictitious strength, gelatin is not to be reckoned amongst the valuable constituents of food.

There is no question that yeast extracts contain albuminous bodies, and that the total nitrogen contained in these extracts is so large as to have led to the vaunt on the part of their vendors that certain of them exceed in worth meat extracts. But when we inquire into the nature of the albuminous bodies present in extracts of yeast, we discover that they are quite peculiarly rich in the nucleo-proteids—the bodies which abound in thyroid, thymus, lymphatic glands, liver, spleen, leucocytes, etc., organs and structures from which the "exogenous purin bases" of the animal body, as we shall afterwards term them, are derived—that is, bodies which all experience leads us to eliminate, as far as possible, from the diet of the arthritic. And how many are the gouty and the arthritic amongst us, especially amongst those who are obliged to eschew beers and wines, and seek for stimulus and support in that which they believe to be a genuine meat extract!

We have said that it is characteristic of yeast extracts to be free from the aroma of meat extracts, to contain neither creatin nor creatinin, and to be peculiarly rich in the objectionable "purin bases." (The mean of ten analyses of meat extract, of which I have cognizance, gave 0.4334 per cent. of purin nitrogen; whilst the mean of eight analyses of yeast extract gave 0.646 per cent. of purin nitrogen—that is, yeast extract contains half as much more purin nitrogen as meat extract.)

But here we are led to ask a question of the very first importance: Are the purin bases of yeast extracts the same, or present in the same relative proportions, as the purin bases of meat extracts? *In no sense.*

On this point the only investigation which has yet been made is the series of researches conducted by Karl Micko.⁶ Micko investigating, by the so-called "Kruger-Salomon" method, three kilograms of Liebig's Extract of Meat and three kilograms of a yeast extract known as the "Dresdner Wurzkraft Extract," separated in each case, so far as our present methods permit, the various purin bases contained in each respectively.

A.—The Purin Bases of Meat Extracts.

On extracting these bases successively, he found that the last extract contained in overwhelming excess hypoxanthin, with a little xanthin; that the second portion contained only hypoxanthin; that the third extract contained also some adenin. Neither guanine nor carnine were discovered.

B.—The Purin Bases of Yeast Extracts.

These were found to consist chiefly of adenin; besides, and arranged in the order of their amount, were guanin, hypoxanthin, and xanthin.

We see, therefore, that not only do yeast extracts contain much larger quantities of purin bases than meat extracts, but that there is the widest divergence between the two extracts, in so far as concerns the representative purin bases which they contain.

III.

Upon what grounds have Infusions of Beef (Beef Tea, Soups, etc.) and Extracts of Meat been employed in dietetics and upon what is their value dependent?

The practice of consuming soups or hot or warm infusions of meat is an ancient one, and these preparations

have generally been used as antecedents of mixed meals; sometimes, however, alone or merely in connexion with bread, by the destitute, hungry, and weary. Even in these days of subversive ideas and of rebellion to all authority, the practice of taking soup has not only continued (and in England greatly extended), but very positive evidence has been adduced in favour of the habit of consuming infusions of meat or solutions of meat extracts. Before discussing, however, positive scientific facts, I would say that they do but reinforce the opinion of the best physicians of all times—to wit, that when a patient is in a condition which incapacitates him from partaking of solid food, particularly of some quantity of animal food, the stimulating effects (the “picking-up effects,” if I may be allowed to use a colloquial expression) of repeated doses of strong beef tea or of meat extracts is incontrovertible. The influenza patient with high, and continuously high, temperature, resisting, that is, unaffected by, safe doses of our antipyretic remedies, who is unable to take any meat diet, who cannot even tolerate milk, pure or diluted (and such cases do occur), is unquestionably very greatly helped by repeated and continued administration of the extractive matters of beef. Let the sceptic affirm that the supposed value is imaginary: the more accurate the physician, the more diligent in determining the physical constants of his patients, the more convinced will he be of the truth of my assertion or, rather, of the soundness of the basis upon which the practice to which I refer reposes.

Liebig's idea with regard to extracts of beef was that they owed their value, merely or chiefly, to the so-called extractive matters, and I think that in the main he was correct; he was unacquainted, however, with the fact, afterwards demonstrated, that certain extracts do contain far from inconsiderable quantities of proteid bodies (chiefly of the albumose and peptone type). Still, we cannot admit that, however concentrated an extract of beef may be, it and the infusions or solutions made from it can contribute much to the total sum of energy which the body expends even when performing a minimum of work.

This is not the place to criticize the values obtained by burning in a calorimeter alimentary substances of which no inconsiderable quantity escapes absorption in the alimentary canal (as Professor Walker Hall has shown to be the case with certain of the purin bases), or which are excreted in the urine very much in the same condition as that in which they enter the body. Still, assuming for the sake of argument that all the calories which, as a result of calorimetrical determinations, are attributed to one ounce of a genuine Liebig Extract of Beef, were really utilized by the human body—and it can scarcely be conceived that a larger quantity than one ounce of any preparation could or would be consumed in the course of twenty-four hours—the actual energy yielded by one ounce of such extract would only supply a small part of the total energy expended by the human body in performing its *essential* vital work (*opus vitale*)—as represented by the work of the heart, the movements of respiration and the energy expended by the muscular movements and the chemical activities of the alimentary canal.

Upon what, then, does the value of beef tea or beef extracts depend?

It was Schiff—who, in spite of the great unreliability of many of his statements, was certainly one of the most suggestive physiologists of the nineteenth century (in passing I may remind the reader that to him we owe, *inter alia*, the fruitful conceptions of the so-called “internal secretions,” of which the part played in the animal economy is every day becoming more important)—who stated that the taking of soups, that is, highly diluted extracts of meat, stimulated in a remarkable manner the activity of the gastric glands, in virtue, as he thought, of the presence of undetermined, hypothetical, *substances peptogènes*. These statements of Schiff, which were but the expression of the results of universal experience of the value of soups (beef extracts) as the first course of a meal, have found absolute confirmation in the splendid researches of the great Russian physiologist, Professor Pawlow, the Nobel Prizeman of St. Petersburg. I cannot in this place refer to the researches of Pawlow in detail. As bearing on the present argument, I shall merely confine myself to pointing out that Pawlow has demonstrated that meat extract by its aroma and doubtless by yet unknown substances which it contains, possesses in a remarkable manner the power

of stimulating the secretion of the gastric juice, in “physical,” “sham,” and “real” feeding.

IV.

Looked at from the Physiologico-Medical point of view, is there any reason for supposing that Yeast Extract, per se, is anything but prejudicial?

We have seen that yeast extracts differ from meat extracts in a startling manner. They contain none of the flavouring and odoriferous principles which cause extracts of beef to be palatable; they are devoid of creatin and creatinin, which, in spite of the obscurity yet enveloping the part which they play, we may consider as characteristic of muscle, its infusions and extracts, and they abound in the “nucleo-proteids,” and we have spoken of these as the mother substances whence the nucleic acids and, originating in them, the purin bases are derived; further, we have stated that the purin nitrogen contained in the yeast extract is half as much more as in beef extracts.

But, further, basing our remarks on the elaborate researches of Micko, we have stated that the prevalent purin bases of yeast are in no sense comparable to, or identical with, those of beef, for whilst in the latter it is *hypoxanthin* which is the predominant partner, in the former (the yeast extracts) it is *adenin*. Although these bodies are closely related, and all the purin bases, in greater or less proportion, are generators of uric acid in the animal organism, our knowledge in no respect permits us to affirm that the adenin of yeast extract is not a much more injurious body, in so far as the animal body is concerned, than the hypoxanthin of beef. It allows us, however, to assert in the strongest possible manner that yeast extracts are *in no sense the same as, or the equivalents of, extracts of beef*.

This appears to me to be the place to add to the information already given in the course of this paper in reference to purin bases. The term springs from the classical researches of Emil Fischer, to whom we owe our knowledge of the purin bases and their relation to uric acid. Fischer considers that each member of the uric acid group is derived from a hypothetical body, purin, C_5N_5 , from which all the purin bases are derived, whether they be of animal or vegetable origin; thus, hypoxanthin is monoxypurin, xanthin dioxypurin, adenin is aminopurin, and uric-acid trioxypurin.

It is to Professor Kossel of Heidelberg and his school that we owe the first and the chief part of our knowledge in reference to the origin of the purin bases as resulting from the decomposition of the nucleins and nucleic acids which are present in the nucleus and the protoplasm of the vegetable and animal cell. The subsequent researches of a number of physiologists and physicians have established on the surest foundations that the whole of the uric acid excreted in the urine of man is derived in part from the metabolism of the muscular and glandular organs (*endogenous* uric acid), and in part (it may be very much the greater part) from the purin bases introduced into the body directly, or derived from their mother substances the nucleins, nucleo-proteids and the nucleic acids. By feeding an animal or a man on liver, or pancreas or thymus, or on yeast extracts, it has been shown that the uric acid excreted can be enormously increased. We term such uric acid as is derived from the foodstuffs introduced into the body, *exogenous* uric acid.*

The production of uric acid, whether it be of endogenous or exogenous origin, is believed, on certain grounds, to be due to, or connected with, a series of “enzymes” or “unformed ferments.” Thus, it is believed that the purin bases which are derived from the nucleins are set free by ferments, to which the name of “nucleases” has been given; that a ferment called “adenase” is able to convert adenin into hypoxanthin; that another ferment, “guanase,” converts guanin into xanthin, whilst a group of so-called “oxydases” converts hypoxanthin into uric acid and xanthin into uric acid.

There are, further, ferments existing in the economy

*It is beyond the scope of this paper to refer to the literature concerning the determination and excretion of the purin bases. It is impossible, however, to pass over without mentioning them the suggestive and path-breaking researches of Burian and Schur, of Burian and Walker Hall, and the fine and independent work of Professor I. Walker Hall, now of Bristol. These are incorporated in his original and interesting book, entitled, *The Purin Bodies of Foodstuffs and the Role of Uric Acid in Health and Disease*. Sheratt and Hughes, 50, Long Acre, London, W.C. (1903.)

which possess the power of destroying the uric acid, or a portion of it when once formed. These we may call *uricolytic ferments*.

IV A.

I wish now to draw *very summarily* attention to the relation of the nucleins, nucleo-proteids, the nucleic acids, and particularly the purin bases, to the formation of uric acid as bearing on the pathology of gout, and as affecting those suffering from gout or the gouty diathesis.

Since the time when Dr. (afterwards Sir) Alfred Baring Garrod first drew attention of the medical and scientific world to the statement that during attacks of gout the amount of uric acid in the blood is increased—whilst prior to, and usually during, an attack of acute gout the amount of uric acid eliminated in the urine is diminished, an abnormal amount being excreted after the attack—the medical profession, especially in England, came to the conclusion that uric acid must be looked upon, in a sense, as the cause of gout, the *materies morbi*. As a matter of fact, the conditions are by no means always as stated above. The uric acid in the blood is not always increased in acute gout, and the conditions of the urine do not always agree with that which is stated above—"uric acid storms," that is, abnormal eliminations of uric acid, sometimes occurring during the acme of the gouty paroxysm.

All kinds of theories and various régimes have been based upon this uric acid hypothesis, which, viewed from the wider standpoint of to-day, are seen to be far from expressing the truth—at any rate, *the whole truth*—on the matter. Believing uric acid (at any rate, the exogenous fraction) to be closely related to a meat diet, there have been many authorities on gout who have insisted upon a complete absence of meat in the dietary of the gouty. It has been shown, however, that the gouty manifestations (even the deposits of chalk stones, which are composed of sodium diurate, in the joints) cannot be explained on the mere uric acid hypothesis. In the first place, the facts of retention of uric acid in the system before an attack of gout and the alleged constant excess of uric acid in the blood are far from constant phenomena; in the second place, it appears that a very moderate meat diet exerts singularly little influence on the excretion of uric acid, even in the gouty, *always providing that the nucleo-proteids, the nucleic acids and the purin bases are (so far as possible) eliminated from the diet*. On the latter matter there appears to be now a consensus of opinion. Still we have to account for or, at any rate, provide the most probable hypothesis to explain the phenomena of the gouty diathesis and the occurrence of attacks of gout. Facts appear to indicate that in the gouty there is a diminished power of the system to deal with the purin bases (so that there is a tendency to their accumulating in the system); it appears probable that this is connected with a deficiency or inefficiency of the ferments which are concerned in their normal transformations—a deficiency or inefficiency which may be due to the action of toxins generated in the body.

It may be, too, that there is a deficiency of, or interference with, the enzymes which normally destroy a part of the uric acid formed, a process which has by several distinguished scientific men been supposed to have its principal, though not exclusive, seat in the liver.

In any case, all authorities on gout are agreed that, so far as possible, the purin bases in the diet should be kept at as low a level as possible.

The force of the arguments advanced in this paper in reference to the use or non-use of yeast extracts will escape no one who is in a position to follow them.

To characterize a preparation which (for the sake of argument) we shall assume to contain 18 per cent. of meat extract added to an extract of yeast mixed with considerable quantities of gelatin, as a preparation which excels in value pure meat extracts, is to endanger the health of the large number amongst us who have succeeded to the unfortunate heritage of the gouty diathesis.

REFERENCES.

- ¹ Ruppel, op. cit., p. 175. ² *Zeitschrift für Biologie*, Band iv., 1868, S. 3.
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A Third Report

ON

CLINICAL EXPERIENCES WITH SPINAL
ANALGESIA:

WITH A

THIRD SERIES OF ONE HUNDRED CASES.

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AMONG the large number and variety of operations performed under different anaesthetics which have fallen to my lot at University College Hospital since my first and second 100 spinal analgesias were completed and published in the *BRITISH MEDICAL JOURNAL* of March 23rd, 1907, and February 1st, 1908, a fresh 100, operated on under the same method of analgesia, are now to be found. These have been carefully noted and entered from day to day in the same form of tables as before by Captain H. Browne-Mason, Lieutenant Treves, and Captain H. Simpson, of the R.A.M.C., to whom I am indebted for the accuracy and fullness of the records, as well as to Mr. H. Morriston Davies, who has checked them. A summary of these tables added to the previous series for the sake of contrast is given below in fifties as before.

SUMMARY OF TABLES.

	Series 1.	Series 2.	Series 3.	Series 4.	Series 5.	Series 6.	Total.
Strangulated herniae ...	4	0	1	2	4	1	12
R. cure herniae ing. fem. vent. ...	10	7	16	11	10	14	68
Acute appendicitis ...	2	5	3	3	3	0	16
Appendectomy à froid ...	5	3	2	3	4	4	21
Gastro-enterostomy ...	0	0	2	1	2	0	5
Other laparotomies ...	4	5	2	2	3	5	21
Kidney operations ...	0	0	0	1	0	0	1
Excis. rectum (Kraske) ...	0	0	1	0	0	0	1
Perforated gastric ulcer ...	—	—	—	—	1	0	1
Ectopic gestation ...	—	—	—	—	1	0	1
Gall bladder ...	—	—	—	—	1	0	1
Total abdominal ...	25	20	27	23	29	24	148
Piles (Whitehead) and fistula ...	7	10	6	9	2	11	45
Pubis and genitals ...	7	6	1	2	8	5	29
Dislocation of hip reduction ...	0	0	0	1	0	0	1
Amputation of thigh, leg, foot ...	1	0	1	1	1	0	4
Internal S. cart. and knee ...	2	2	5	5	1	1	16
Wiring fractured patella ...	0	3	2	2	0	2	9
Other operations on lower limb ...	6	8	8	7	8	6	43
Failed to puncture dural sac ...	2	1	0	0	1	1	5
Total abdominal ...	25	30	23	27	21	26	152
Total abdominal ...	25	20	27	23	29	24	148
	50	50	50	50	50	50	300
General anaesthetic required ...	14	0	6	0	3	0	

The study of these 300 consecutive cases, operated on in the same hospital and by the same surgeon, appears to possess a certain value, and the results are now placed at the disposal of others. It would seem to me premature to adopt any decisive attitude towards this comparatively new procedure. It is still *sub judice*, and must long